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Stylized Facts of Business Cycles, Excess Volatility and Capital Flows: Evidence from Mexico and Turkey

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Abstract

This paper analyses the stylized facts of business cycles in Mexico and Turkey, by comparing the results obtained for the United States. Excess volatility of real output as well as the relative volatility of consumption seems to be a problem for real business cycle models to account for. Fiscal policies and money do not yield clear-cut patterns. Both the price levels and the inflation rates turn out to be moving countercyclically, suggesting the appropriateness of a supply-driven business cycle model rather than a demand-driven one for Mexico and Turkey. Labour inputs and productivity are procyclical but do not lead the output cycle. Capital inflows, especially long-term capital inflows seem to matter since they turn out to be strongly procyclical and lead the cycle by one quarter. This observation is also consistent with the result of a supply-driven model's relevance for the two countries.

Keywords: Real Business Cycles, Capital Flows, Emerging Markets

JEL Classification: C8; E1; E3; E5

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I. Introduction

Understanding the presence of common elements in the cyclical patterns of a wide range of variables including prices, outputs, employment, consumption and investment, and distinguishing the factors affecting these patterns have been the main areas of research in empirical macroeconomics in the recent years. Several authors, including Kydland and Prescott (1990), Fiorito and Kollintzas (1994), Chadha and Prasad (1994), Gregory, Head and Raynauld (1997), Canova and De Nicolo(1998), and Bjornland (2000) among others, have concentrated on documenting the properties of cycles in developed countries using a variety of different methods.

Since societies would prefer a relatively "steady" growth path with less uncertainty, it is important for a policy maker to know the sources of business cycles, that is, whether fluctuations in economic activity is primarily attributable to movements in, or shocks to, demand or supply. The "comovement" of prices with "aggregate economic activity" is an important indicator for distinguishing the relatively more important source of fluctuations. If prices are moving in the same direction with output in an economy, this is suggestive of the importance of demand side disturbances, and conversely, if the prices are falling when the production is expanding and vice versa, this may indicate the relative importance of supply side shocks. Under the condition that shocks to demand constitute the relatively more important source of fluctuations, there is room for Keynesian "leaning against the wind" type fiscal and monetary policy interventions. However, if the primary sources of output fluctuations are caused by optimal response of agents to unforeseen supply side shocks as explained by the real business cycles theory[1], the policy makers might be better off abstaining from exercising such "discretionary" policies and stick to widely announced simple rules as advocated by Friedman and the monetarist school to reduce uncertainty.

Empirical studies faced with the problem of documenting broad regularities of business cycles differ in terms of extracting the cyclical component of the macro variables and analysing the comovements of these components. One strand of literature isolates the

[1] See for example Kydland and Presott (1982) and Prescott (1986).

cyclical component by deseasonalizing and detrending the data through various filtering procedures and then looks at contemporaneous correlations between output and various macro variables; see for example, Kydland and Prescott (1990) for the United States, Backus and Kehoe (1992) for the G-7 less France, Australia, Denmark, Norway and Sweden, Fiorito and Kollintzas (1994) for the G-7, and Bjorn (2000) for Norway. One other strand imposes *a priori* restrictions on the long-run multipliers of VAR shocks to obtain information about the structural sources of disturbances; see for example Blanchard and Quah (1989) for the United States using bivariate modelling and Canova (1998) for the G-7 using multivariate modelling. Additionally, asymmetric behaviour of the economies over the business cycles, namely the observation that the amount of time it takes to reach from the trough of a cycle to its peak is much longer than the time from the peak to the trough, have been incorporated into estimations using Markov-switching models with time varying transition probabilities; see for example Neftçi (1984) and Hamilton (1989) for the United States.

The studies mentioned above for the developed countries reported "countercyclical prices" which seemed to suggest the importance of the supply side shocks, supporting the real business cycles theory. However, Chadha and Prasad (1994) reported for the same group of countries that even though the prices are countercyclical, inflation rates are procyclical and hence the evidence does not necessarily falsify the demand-driven models of the business cycles. Additionally, Canova (1998) reported that in Canada, France, Germany and the United Kingdom, output shocks primarily reflect monetary disturbances; in Japan, they are driven by the supply side disturbances, and in Italy and the United States, they are driven by a combination of supply and monetary disturbances.

The aforementioned empirical studies have all attempted to identify the sources of fluctuations in developed countries. Taking into account the fact that output fluctuations are relatively more intense in developing countries, it is of particular interest to understand the sources of fluctuations in these economies to find ways to smoothen them to the levels of developed economies. Due to the unavailability of good quality national accounts data for the developing countries as well as the existence of the methodological problem of extracting the cyclical component of the output series when crises are very frequent, research on the developing economies have at best been limited. Previous empirical papers on business

cycles in developing countries have either used monthly and quarterly data on industrial production index as the aggregate measure of output and analysed nominal business cycles[2], see for example, Melnick and Golan (1991) for Israel, Kim (1996) for Korea and Taiwan, Agenor et al (1997) for a group of 12 developing countries, and Alper (1998) for Turkey, or have analysed the real business cycles with annual data sets, see for example Schuknecht (1996) for a panel of 35 countries, Mejia-Reyes (2000) for eight Latin American countries and Metin et al. (forthcoming) for Turkey. An exception to this has been Kydland and Zarazaga (1997) who used quarterly data on national accounts to investigate real-shock account of business cycles for Argentina even though their reports are obtained from using two different estimates of GDP and its components. The purpose of this paper is to investigate the basic stylised facts of business cycles in two developing economies Mexico and Turkey using quarterly data from 1987 to 2000. Empirical results obtained from quarterly data for the United States will also be reported due to two reasons: first to serve as a benchmark representing developed economies and second to check for robustness of the results for this particular sample period.[3] The discussions on the results obtained will also include results obtained by Kydland and Zarazaga (1997) for Argentina as well as the aforementioned research on developing economies.

Other than for the reason of "availability of data" for quarterly national income accounts, the rationale for the choice of the two countries, namely Mexico and Turkey needs to be provided. Even though the two countries have similar as well as differing characteristics, their economic experiences have been more similar than different when we consider the past two decades. Both countries have experienced high and chronic inflation, various stabilization efforts, financial trade liberalizations, and financial crises. Mexico has 92.7 million inhabitants who are relatively young with 35.5% under 15 years of age, while the figures are 62 million and 31.2%, respectively, for Turkey. Both countries are relatively urbanized with the urbanization rates standing at 75% and 69% for Mexico and Turkey, respectively. According to the *Economist*, GDP per head by the end of 1999, adjusted for purchasing power parity and set at 100 for the United States, is 28 for Mexico and 22 for

[2] That is, data on national expenditure and its sub components were unavailable.
[3] The particular sample period is chosen due to the availability of data on the Turkish national accounts on a quarterly basis for the post-1987 period.

Turkey. Both countries experienced short-term and long-term capital inflows[4] following trade agreements with developed neighbouring countries or a group of countries.[5] The similarities in economic experiences by the two countries have been taken up in other studies as well; see for example, Yentürk (1995) and Altuð and Yýlmaz (1998) among others.

Similar to the results obtained for the developed countries, Alper (1998), using monthly series for 1980-1997, reported countercyclical prices for Turkey. However, the inflation rate turned out to be also countercyclical which is different from the procyclical behaviour of inflation rates observed for the G-7 (See Fiorito and Kollintzas, 1994, and Chadha and Prasad, 1997, among others). The observed countercyclical behaviour of prices and the inflation rate suggested a model with supply-determined sources of fluctuations for Turkey. Altuð and Yýlmaz (1998) conducted a VAR analysis to analyse the relation between asset returns, inflation and real activity and reported that, similar to the case of Turkey, a shock to inflation has a significant negative effect on industrial production in Mexico. The countercyclical behaviour of the inflation rates in Mexico and Turkey, which has not been observed in other developed as well as developing countries, provides yet another motivation for the study of business cycle similarities in these two countries.

In section II, data and the methodology is explained briefly. The methodology borrows heavily from Kydland and Prescott (1990) in decomposing the series into nonstationary (trend) and stationary (cyclical) components by employing the filter proposed by Hodrick and Prescott. By considering three other filtering techniques, robustness of the results due to the choice of the detrending technique is checked and the results are reported at the Appendix B. In section III, empirical analysis of the business cycles regularities in Mexico and Turkey, their comparison to the United States and other developing countries is given. Section IV concludes.

[4] The magnitudes of capital inflows were larger for Mexico. During the 1987-1998 period, median net portfolio investment in Mexico was 2.428 million U.S. dollars, whereas the same figure for Turkey stood at 890.5 million U.S. dollars. Median net direct investment stood at 4.567.5 and 617 mil U.S. dollars, respectively, for Mexico and Turkey. The amounts of capital flows to Mexico and Turkey are given in Appendix A.

[5] The North America Free Trade Agreement (NAFTA) that was signed by Mexico, Canada and the United States on December 1992, came into effect on January 1, 1994. For the case of Turkey, a 22-year timetable that was set in 1973 for achieving a Customs Union prior to full membership with the European Union, came into effect on January 1, 1996. Also, after the break-up of the Soviet Union, the close historical ties of Turkey with the newly formed Central Asian Republics, underlined the strategic importance of Turkey for foreign investors.

II. Data and Methodology

The quarterly data for Mexico, Turkey and the United States come from four different sources, namely, the Main Economic Indicators published by the OECD, International Financial Statistics by the IMF, and from the web sites of the Federal Reserve Bank of St. Louis and the Central Bank of Turkey. Apart for a few exceptions, the range for the data starts from the first quarter of 1987 and ends at the second quarter of 2000 implying a maximum of 54 observations. For Mexico, National Accounts data are from the IFS and the manufacturing productivity and real wage data are form the Main Economic Indicators. For Turkey, the National Accounts and Monetary Survey data are from the web site of the Central Bank of Turkey, the manufacturing productivity and real wage data are form the Main Economic Indicators, and the rest from the IFS. For the United States, data used in analyses are obtained from the web site of the Federal Reserve Bank of St. Louis.

Traditional univariate methods of analysing economic time series are mainly concerned with decomposing the variation in a particular series into trend, seasonal, cyclical and irregular components. The decomposition method for a series is not unique and certain systematic assumptions about the nature of and the interaction among the trend, seasonal, cyclical and irregular components are needed to identify the series. For example, the seasonal component may be deterministic/stochastic or multiplicative/additive in nature. Since there are no guidelines from the microeconomic theory about the functional forms of the aggregate series, we follow the standard practice of the real business cycle literature and assume multiplicative seasonal, cyclical and trend components. We start out by deseasonalizing the data using the Census X-11 multiplicative method for variables taking on positive values only, such as prices and output data.[6]

Let Y_t be a series of interest that is already deseasonalized. We take natural logarithm of the series in order to smoothen the changes in it and then we wish to remove the trend component of the deseasonalized series. We employ the spline function proposed by Hodrick and Prescott (1997) that extracts the long-run component of the $\ln Y_t$ series, g_t, leaving $\ln Y_t$

[6] For variables such as change in stocks as well as capital inflows, we use Census X-11 additive method.

stationary up to the fourth order. The trend component is chosen to minimize the following quadratic expression:

$$\sum_{t=1}^{T}(\ln Y_t - g_t)^2 + 1{,}600\sum_{t=2}^{T}[(g_{t+1} - g_t) - (g_t - g_{t-1})]^2$$

and the detrended variable is equal to the difference between $\ln Y_t$ and g_t. The filter proposed by Hodrick and Prescott (henceforth, HP) allows the trend component to change slowly across time.[7]

Figure 1 shows the deseasonalized, linearized real GDP series, as well as the smoothed trend and the cyclical components for Mexico, Turkey and the United States.

The cyclical component of the series illustrate the effects of the "Peso crisis" at the end of 1994 in Mexico, as well as the effects of the 1994 currency crisis in Turkey (see Özatay, 1996). The HP-trend components seem to capture the nonstationary component of the real output series in the three countries rather well.

After deseasonalizing, linearizing and detrending the series, an analysis of the cross correlations between cyclical components of GDP and other variables up to four quarters is made for the three countries. Following the standard practice in the literature, a variable is defined to be procyclical (countercyclical) with the movement of the cyclical component of GDP if the contemporaneous cross correlation (cross correlation at time t=0) is positive (negative), i.e. $\rho(0)>0$ ($\rho(0)<0$). The unknown population contemporaneous correlation coefficient is taken to be strongly significant when the $|\rho(t)|>0.65$, weakly significant when $0.30<|\rho(t)|<0.65$, and insignificant if $|\rho(t)|<0.30$. The cut-off point 0.30 is chosen since

[7] The Hodrick Prescott filter has been subject to criticisms, see for example, King and Rebelo (1993), and Cogley and Nason (1995). However, previous research on the monthly Turkish data by Alper (1998) reveals insignificant differences in results when an alternative filter is considered. In the Appendix B, autocorrelations of the cyclical components of the GDP and the Industrial Production Index for Mexico, Turkey, and the US, obtained using four detrending methods are given, namely, the HP filter, first difference, four-quarter percentage change and quadratic trend. Similar to results obtained by Fiorito and Kollintzas (1994) for the G-7 countries, quadratic trend method and the HP filter produced similar results. Definitions of the filters are available from the authors upon request.

approximately 0.268 corresponds in our sample of 54 quarterly observations to the value required to reject at the 5% level of significance of the null hypothesis that the unknown population correlation is equal to zero in a two-sided test under the assumption that the two random variables are distributed bivariate normally. If the highest correlation between a particular variable and GDP occurs when the variable is shifted backwards (forwards), then the variable is defined to be leading (lagging) the cycle.

III. Empirical Analysis of Business Cycle Regularities

In tables 1-3, the standard deviations of the cyclical component of each variable and the cross correlations of the variables with the cyclical component of the real GDP in Mexico, Turkey, and the United States are reported. The highest degree of comovement of each variable with real output is printed in bold if the correlation coefficient is at least weakly significant. A row containing no bold figure suggests that the series is acyclical, that is the cyclical component of the series is uncorrelated with the cyclical component of real output.

Table 1 reports statistics obtained from data on real GDP and the components of spending. The first set of rows report persistence of the shocks in the cyclical components of the real GDP that are strongly positively correlated, persistence of the shocks being highest in the United States (the first autoregressive coefficient is 0.82) and lowest in Turkey (0.58). The values of persistence also conform to the findings of Fiorito and Kollintzas (1994) for the G-7 countries. Using quarterly data for the period 1960-1990, Fiorito and Kollintzas report the highest first-degree autoregressive coefficient for the United States (0.85) and the lowest for the United Kingdom (0.55).

The striking difference is the observed relatively high volatilities of real GDP in Mexico and Turkey. The percentage standard deviation of the cyclical component of real GDP in Mexico and Turkey are roughly 2.63 and 3.91 times larger than for the United States, respectively. Kydland and Zarazaga (1997) report the volatility of real GDP in Argentina to 2.5 times larger. When compared to the observed volatilities in the G-7 as reported in Fiorito and Kollintzas (that ranges between 0.90 for France and 1.74 for the United States), owing to stabilizations and frequent crises, the volatility values in these developing economies are

significantly higher. The observed *ex-post* high volatilities introduce higher *ex-ante* risk in these economies, resulting in higher risk premiums and lower rates of growth. A recent paper by Denizer et al. (2000) relates the excess volatility in output to the inexistence of developed financial sectors and the private sector finance.

The statistics belonging to the consumption expenditure point out to an anomaly that is also observed by Kydland and Zarazaga for Argentina: the consumption expenditure is relatively more volatile than real income in Mexico and Turkey. This observation is also noteworthy since consumption is less volatile in the G-7 countries relative to income. Observed relatively high consumption volatility in Mexico and Turkey is against the consumption smoothing behaviour as posited by the Life Cycle/Permanent Income Hypothesis. Even though, the observed volatility may be due to credit constraints as explained by Denizer et al., recent papers by Caroll (1996) and Gourinchas and Parker (2000) showed that it may also be due to the striking change in the consumer behaviour over the life-cycle. Young consumers faced with important income uncertainty may behave like buffer stock agents if they are sufficiently impatient. Around age 40, the observed typical household in the United States starts accumulating liquid assets for retirement, conforming to the Life Cycle/Permanent Income Hypothesis. When the average population age in Mexico and Turkey are considered and compared to developed countries, their population is relatively young with the percentage of population less than 15 years of age being respectively, 35.5% and 31.1%. The relatively high consumption volatility may be due to the buffer-stock behaviour by the population in these countries. This implies a reduction in the observed relative volatility as their average age of the populations start to increase eventually. Also, when durable good consumption expenditure is excluded, the relative volatility of consumption in Turkey drops below the value for real GDP, even though the value is still considerably higher than the United States.

In considering the contemporaneous correlation between the cyclical components of real GDP and consumption, the values are relatively high in Turkey (0.91) and close to the value of (0.96) observed for Argentina by Kydland and Prescott (0.96). Such high correlation figures imply that the cyclical shocks to income are perceived as permanent and hence affect consumption. When the durable goods consumption is excluded, the contemporaneous

correlation drops to 0.86 for Turkey, which is still high for the business cycles models to explain.

As observed in Kydland and Prescott (1990) for the United States, Fiorito and Kollintzas (1994) for the G-7 countries, and Kydland and Zarazaga (1997) for Argentina, investment expenditures and inventory investment as a subcomponent constitute the most volatile components of the real GDP. However, unlike the figure reported for Argentina by Kydland and Zarazaga (2.90), the contemporaneous correlation of fixed investment and output in Mexico and Turkey are roughly 3 times greater than the United States during the 1987-2000 period.

The acyclical behaviour of the change in stocks in Mexico and Turkey and construction investment in Turkey are also different than the procyclical figures for the United States and Fiorito and Kollintzas' findings for the G-7 economies. Business cycles results for the subcomponents of fixed investment are not available for any other developing economy, and more research is needed prior to naming this observed phenomenon a stylised fact for the developing economies.

Fiorito and Kollintzas report differences for the G-7 countries in empirical regularities concerning the cyclical correlation of real output with government final consumption which may depend on a variety of factors such as the evolution of institutions, the weight of military expenditures in the total budget, and the existence of stabilization programmes. Cross correlations indicate procyclical government consumption for each of the three countries. The government consumption is synchronous in Turkey, lagging the cycle of real output by one quarter in Mexico and lagging the cycle by four quarters in the United States. Even though cyclical components of the final government consumption are procyclical, these do not necessarily imply the efficacy of the fiscal policies in any of the countries, since they are not leading the cycle.

The behaviour of exports and imports in Turkey and the United States are similar to results obtained by Fiorito and Kollintzas for the G-7 countries. Exports are weakly procyclical and synchronous whereas imports are strongly procyclical and synchronous. Curiously, Mexican

exports are strongly countercyclical and are leading the cycle by one quarter, while Mexican imports are weakly countercyclical and are also leading the cycle by one quarter. Even though the countercyclical and leading behaviour of imports may be explained by import booms at the end of failed stabilization programmes that leads to a balance of payments crisis, countercyclical behaviour of exports remains a puzzle as observed by Kydland and Zarazaga for Argentina as well. As suggested by Kydland and Zarazaga, this may be due to faulty reporting by exporters in Argentina and Mexico.

Table 2 reports statistics for price and monetary variables. The comovements of the real GDP and the money stock as measured by the reserve money, the central bank money (also includes open market operations by the central bank), M1 and M2 do not show a clear-cut pattern. The acyclical pattern of the central bank money obtained for the United States is different than the synchronous weakly procyclical monetary base pattern obtained by Kydland and Prescott (1990) for the period 1954-1989. In Turkey, during the period 1987-1999, the central bank basically took the fiscal policy and hence the budget deficit as exogenous, and attempted to minimize large fluctuations in the interest and the exchange rates. For this reason, monetary policy was endogenously determined and *a priori* expectations for the cyclical behaviour of the money stock controlled by the central bank was acyclical. Even though the reserve money is acyclical as expected, the central bank money is weakly procyclical and is leading the cycle by a quarter. The narrow definition of the money stock, M1 is weakly procyclical and is also leading the cycle by a quarter in Mexico and Turkey. However, when broader definitions, quasi money definitions, as well as the velocities associated with these definitions are considered, there is no clear-cut pattern for Mexico, Turkey or the United States. In general, a real business cycle model tailored for the developing economies should not attach a very important role to the monetary policy, since generally, the amount of money stock in these economies are endogenously determined by such factors as the size of the budget deficit, the ability by the Treasury of the countries to borrow from the domestic and the international markets, amount of capital inflow and existence of an international financial crisis, among others. To the extent that money supply definitions are unable to effect the expected long-term real interest rate, endogenous changes in the money supply will not effect the cycle of the real output.

Confirming the findings of Fiorito and Kollintzas (1994) for the G-7, both GDP deflator and consumer prices in Mexico, Turkey and the United States are countercyclical. However, as also pointed out in Alper (1998), Mexico and Turkey have inflation rates that are synchronous and countercyclical, even though the United States has procyclical and lagging inflation rate. In order to get around the distortions introduced by different forms of price controls, the nominal exchange rate in levels and its annual depreciation rate are also considered for Mexico and Turkey. Both the nominal exchange rate level and the annual depreciation rate similar to the price levels and the inflation rates turn out to be countercyclical. Even though countercyclical behaviour of price levels is a widely observed phenomenon, countercyclical behaviour of inflation rates is not; see for a thorough discussion Chadha and Prasad (1994). This observed phenomenon implies that supply-driven models of the business cycle may be more accurate representations of reality in Mexico and Turkey than conventional demand driven models.

Next, the effect of cyclical shocks to the world and industrial countries' price levels and inflation levels on Mexico and Turkey are considered. Since Mexico and Turkey can be considered as small open economies, world price fluctuations may be transmitted on to their real output through trade channels. Just like domestic prices, world prices seem to be countercyclical. However, it is difficult to get a stylised pattern, since for Mexico, the world CPI leads the cycle by 4 quarters, whereas for the case of Turkey, it lags the cycle by four quarters. On the other hand, industrial countries' CPI is procyclical and leads the cycles of Mexico and Turkey by three quarters presumably reflecting an increase in demand for the Mexican and Turkish exports. Just like the world inflation rate, the Industrial countries' CPI based inflation rate yields contradicts results for Mexico and Turkey.

Both Mexico and Turkey have liberalized capital movements at the latter half of 1980s completely in the hope of attracting foreign money to finance their public sector borrowing requirements, which would reduce the prevailing high real interest rates, and decrease the crowding-out in private investment. 1990's witnessed a boom in financial flows to these capital deficient economies. The surge of foreign capital into Turkey due to high rates of return helped finance the government budget deficit; but, alas, it was unable to reduce the high real interest rate. This stemmed from the fiscal extravagance once the amount of funds

available to the domestic economy increased. The existence of foreign capital worked like a two-edged sword. On the one hand, it stimulated growth; on the other, it increased the probability of macroeconomic mismanagement.

The relation between the growth rates and the gross short-term capital inflows for Mexico, Turkey and the United States are given in Figure 2.[8] As can be observed clearly, consistent with the fact that supply-driven model is more relevant for Mexico and Turkey, growth is very much related to the capital flows in these countries whereas growth seems to be independent of the capital flows in the United States[9].

Statistics in table 2 indicate that the capital flows are procyclical for Mexico and Turkey and acyclical for the United States. For Mexico and Turkey, net short-term capital flows are leading the cycle by one quarter and are weakly procyclical. For Turkey, gross long-term capital inflows are strongly procyclical and are leading the cycle by one quarter. For Mexico, Gross long-term capital inflows are at best barely weakly procyclical and are leading the cycle by two quarters. Real interest rates do not seem to matter for Mexico and Turkey, implying the inflows being expectations driven rather than responding to the changes in the real interest rates. Contrary to findings of Fiorito and Kollintzas for the 1960-1989 period, the real interest rate is procyclical and synchronous for the United States during 1987-1999.

Consistent with the findings of Kydland and Prescott (1990) and Fiorito and Kollintzas (1994), labour input, in terms of employment, is procyclical and synchronous for Mexico and Turkey and lagging for the United States. Hours per worker and total hours worked are also procyclical and for Turkey, Mexico, and the United States. However, there is no evidence that productivity is leading the manufacturing production cycle in any of the three countries. This is hard to justify in terms of the real business cycles theory. Fiorito and Kollintzas also present similar findings for the G-7. Conforming to the results of Kydland and Zarazaga (1997) for Argentina, Mexican and Turkish total hours in manufacturing is much more

[8] Short-term capital inflows are the positive values of portfolio investment obtained from the IFS. Long-term capital inflows include the foreign direct investment and other investment. Gross flows do not subtract the investment made by domestic residents abroad.

[9] Similar picture is observed when long-term gross investment, long-term net investment and short-term net investment along with the countries' growth rates are plotted. These plots are available from the author upon request.

volatile than the United States. This finding reflects the existence of labour market restrictions in the developing economies. Faced with high costs of firing labour, firms tend to contract labour hours during recessions.

IV. Conclusions

This study attempted at uncovering sources of business cycles in developing small open economies by presenting evidence from Mexico and Turkey and contrasting the results to the United States for the 1987-2000 period. Results for G-7 countries by Fiorito and Kollintzas (1994) and Argentina by Kydland and Zarazaga (1997) are very frequently mentioned to arrive at general conclusions in terms of similarities and differences of stylised facts of business cycles in developed and developing countries. Unavailability of good quality quarterly data on national accounts of developing economies restrict applied researchers to either conduct their research with annual data missing very important short-run dynamics, or use a restricted data sets in their analysis. In terms of past economic experience both Mexico and Turkey have experienced high and chronic inflation, various stabilization efforts, financial trade liberalizations, and financial crises. Mexico's signing of the NAFTA agreement and Turkey's customs union arrangement with the European Union as well as her close historical ties with the Central Asian Republics, lead to high and variable capital inflows to the countries. Main findings of this study can be summarized as follows:

Volatilities of the cyclical component of real output in Mexico and Turkey are much higher than in the United States. Consumption expenditure is also more volatile than real output in Mexico and Turkey contrary to the Permanent Income/Life Cycle theory of consumption smoothing behaviour. This may presumably be due to the existence of credit constraints or the age patterns of the populations in Mexico and Turkey that are relatively young consistent to the model by Gourinchas and Parker (1999). When durable goods consumption is subtracted, the Turkish consumption volatility drops below the volatility of real GDP.

Similar to developed countries, investment is the most volatile component of the national income, equipment investment being the most volatile component. However, changes in

stocks and construction investment both turn out to be acyclical demanding further inquiry to this anomaly.

Government final consumption is procyclical in Mexico and Turkey but is not leading the cycle to blame unexpected shocks to fiscal policies for the sources of business cycles.

Business cycle analysis using different money supplies do not result in a clear-cut pattern. Reserve money and the central bank money do not come up procyclical and leading the cycle.

Price variables both in levels and in annual growth rates turn out to be countercyclical giving support to the view that supply-side determined business cycle models are more relevant for developing economies than demand-driven models. Such strong conclusion could not have not been arrived at for the developed economies, since even though the price levels are countercyclical, inflation rates turned out to be procyclical; see Chadha and Prasad (1994).

Finally, capital inflows seem to be important, consistent with the previous result of the relevance of the supply-driven business cycle models. Especially for Turkey, Gross Long-term capital inflow turned out to be strongly procyclical and lead the cycle by one quarter.

The empirical regularities summarized above will presumably be addressed in models of business cycles for developing economies and may be used as aguide to smoothen the excess observed volatilities to the levels of the developed economies.

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Table 1

Cross Correlations of Real GNP/GDP with the Components of Spending, Income, and Output in Levels

Variable X	Vol.	X_{t-4}	X_{t-3}	X_{t-2}	X_{t-1}	X_t	X_{t+1}	X_{t+2}	X_{t+3}	X_{t+4}
(1) *Real GNP/GDP*										
Mexico	2.34	0.12	0.18	0.48	0.77	1,00	0.77	0.48	0.18	0.12
Turkey	3.48	-0.22	0.08	0.32	0.58	1,00	0.58	0.32	0.08	-0.22
USA	0.89	0.14	0.35	0.59	0.82	1,00	0.82	0.59	0.35	0.14
(2) *Consumption Expenditure*										
Mexico	3.98	-0.04	0.17	0.43	0.69	**0.83**	0.65	0.52	0.39	0.32
Turkey	3.85	-0.19	0.14	0.32	0.58	**0.91**	0.63	0.34	0.11	-0.19
USA	0.87	0.21	0.39	0.59	0.76	**0.86**	0.72	0.55	0.37	0.17
(2a*) less Durable Goods Consumption Expenditure*										
Mexico	-	-	-	-	-	-	-	-	-	-
Turkey	2.64	-0.17	0.14	0.28	0.52	**0.87**	0.60	0.30	0.10	-0.21
USA	0.64	0.14	0.31	0.53	0.73	**0.86**	0.77	0.62	0.44	0.23
(3) *Fixed Investment*										
Mexico	7.90	0.08	0.22	0.46	0.70	**0.87**	0.72	0.48	0.20	-0.00
Turkey	8.51	-0.19	0.01	0.27	0.55	**0.83**	0.63	0.42	0.14	-0.14
USA	2.79	0.32	0.50	0.67	0.79	**0.85**	0.71	0.50	0.26	0.01
(4) *Equipment Investment*										
Mexico	-	-	-	-	-	-	-	-	-	-
Turkey	17.45	-0.14	0.08	0.26	0.55	**0.77**	0.62	0.39	0.07	-0.26
USA	2.59	0.32	0.50	0.65	0.75	**0.84**	0.74	0.58	0.37	0.14
(5) *Construction Investment*										
Mexico	-	-	-	-	-	-	-	-	-	-
Turkey	4.92	-0.11	-0.12	-0.11	-0.08	-0.03	0.06	0.09	-0.03	-0.13
USA	5.32	0.43	0.55	**0.64**	0.63	0.54	0.29	0.02	-0.23	-0.43
(6) *Changes in Stocks*										
Mexico	101.08	0.09	-0.00	-0.03	-0.08	-0.10	-0.16	-0.20	-0.23	-0.22
Turkey	552.39	0.05	0.17	0.27	0.16	0.15	-0.17	-0.42	-0.55	-0.52
USA	146.48	0.24	0.29	0.40	0.46	**0.49**	0.33	0.03	-0.28	-0.35
(7) *Government Final Consumption*										
Mexico	7.97	-0.18	0.08	0.27	0.43	0.49	**0.55**	0.46	0.35	0.22
Turkey	3.48	-0.12	-0.11	0.07	0.19	**0.34**	0.30	0.17	-0.03	0.02
USA	0.94	-0.49	-0.46	-0.32	-0.15	0.03	0.08	0.17	0.27	**0.37**
(8) *Exports*										
Mexico	11.45	-0.13	-0.32	-0.54	**-0.73**	-0.64	-0.49	-0.37	-0.26	-0.22
Turkey	6.40	-0.02	-0.01	0.11	0.18	**0.38**	0.29	0.30	0.34	0.17
USA	2.66	-0.08	0.04	0.16	0.31	**0.43**	0.35	0.27	0.22	0.17
(9) *Imports*										
Mexico	4.59	-0.16	-0.29	-0.45	**-0.51**	-0.29	-0.22	-0.22	-0.23	-0.24
Turkey	11.33	-0.18	0.13	0.40	0.65	**0.84**	0.55	0.20	-0.10	-0.34
USA	1.88	0.17	0.30	0.48	0.65	**0.73**	0.60	0.37	0.17	0.04

Note: “Vol.” denotes the percentage standard deviation of the cyclical component of the series.

Table 2
Prices and Monetary Variables

Variable X	Vol.	X_{t-4}	X_{t-3}	X_{t-2}	X_{t-1}	X_t	X_{t+1}	X_{t+2}	X_{t+3}	X_{t+4}
(1) *Reserve Money*										
Mexico	9.31	0.16	0.13	0.10	0.12	0.09	0.09	0.03	-0.04	-0.03
Turkey	6.88	0.14	0.06	0.03	-0.14	-0.26	-0.22	-0.08	-0.08	0.02
USA	6.33	0.14	0.12	0.16	0.02	-0.10	-0.23	-0.34	-0.35	**-0.39**
(2) *Central Bank Money*										
Mexico	-	-	-	-	-	-	-	-	-	-
Turkey	13.07	0.18	0.23	0.23	**0.33**	0.17	0.13	0.02	-0.19	-0.24
USA	1.88	0.13	0.07	0.07	-0.01	-0.08	-0.14	-0.19	-0.22	-0.25
(3) *M1*										
Mexico	13.71	0.36	0.47	0.52	**0.54**	0.50	0.40	0.29	0.15	0.08
Turkey	6.69	0.18	0.35	0.41	**0.44**	0.24	0.02	-0.11	-0.15	-0.24
USA	3.34	0.24	0.20	0.13	0.04	-0.08	-0.21	-0.30	-0.39	-0.49
(4) *M2*										
Mexico	8.68	0.37	0.24	0.10	-0.00	-0.08	-0.13	-0.19	-0.24	-0.26
Turkey	8.29	0.42	0.48	0.39	0.23	-0.09	-0.25	-0.19	-0.17	-0.12
USA	1.27	-0.22	-0.18	-0.14	-0.08	-0.02	0.02	0.13	0.21	0.29
(5) *M3*										
Mexico	7,51	**0,31**	0,21	0,11	0,08	0,09	0,10	0,06	-0,03	-0,11
Turkey	7,95	0,39	**0,48**	0,42	0,32	0,02	-0,17	-0,11	-0,11	-0,12
USA	1,63	-0,03	0,04	0,13	0,25	0,35	0,35	0,38	0,38	**0,38**
(6) *M2 less M1*										
Mexico	11,04	0,24	0,06	-0,11	-0,23	-0,29	-0,30	-0,31	-0,30	-0,30
Turkey	10,43	0,47	0,51	0,37	0,14	-0,18	-0,32	-0,21	-0,17	-0,09
USA	2,66	-0,26	-0,22	-0,17	-0,09	-0,00	0,09	0,21	0,31	0,41
(7) *M3 less M1*										
Mexico	8,84	0,18	0,02	-0,12	-0,16	-0,12	-0,07	-0,07	-0,09	-0,15
Turkey	9,07	0,43	0,49	0,40	0,24	-0,05	-0,22	-0,12	-0,10	-0,08
USA	2,88	-0,10	-0,05	0,04	0,15	0,25	0,30	0,36	0,40	**0,43**
(8) *Velocity of M1*										
Mexico	12,69	0,39	0,45	**0,47**	0,44	0,36	0,30	0,23	0,13	0,08
Turkey	6,59	0,31	0,30	0,23	0,13	-0,27	-0,29	**-0,30**	-0,19	-0,11
USA	3,57	0,22	0,11	-0,02	-0,17	-0,32	-0,40	-0,43	-0,45	**-0,50**
(9) *Velocity of M2*										
Mexico	9,17	0,35	0,18	-0,03	-0,20	**-0,33**	-0,32	-0,30	0,27	-0,24
Turkey	9,24	0,46	0,38	0,21	-0,01	-0,44	**-0,45**	-0,30	-0,17	-0,00
USA	1,54	-0,26	-0,35	-0,46	-0,53	**-0,58**	-0,44	-0,22	-0,02	0,16
(10) *Velocity of M3*										
Mexico	7,65	0,30	0,14	-0,04	-0,16	-0,21	-0,13	-0,09	-0,09	-0,11
Turkey	8,23	0,45	0,38	0,24	0,04	-0,39	-0,40	-0,25	-0,13	0,00
USA	1,56	-0,11	-0,16	-0,20	-0,21	-0,21	-0,11	0,05	0,19	0,30

Note: "Vol." denotes the percentage standard deviation of the cyclical component of the series.

Table 2 (Cont'd)

Variable X	Vol.	X_{t-4}	X_{t-3}	X_{t-2}	X_{t-1}	X_t	X_{t+1}	X_{t+2}	X_{t+3}	X_{t+4}
(11) *Implicit GDP Deflator*										
Mexico	10.84	0.28	0.11	-0.10	-0.29	**-0.39**	-0.38	-0.32	-0.27	-0.24
Turkey	5.91	0.09	-0.00	0.04	-0.01	-0.22	-0.05	0.00	-0.05	0.07
USA	0.29	-0.56	-0.63	**-0.64**	-0.56	-0.40	-0.18	0.02	0.19	0.36
(12) *GDP Deflator Based Inflation*										
Mexico	40.88	0.11	-0.11	-0.36	-0.62	**-0.68**	-0.56	-0.33	-0.09	0.06
Turkey	16.70	-0.13	-0.20	-0.07	-0.07	**-0.30**	-0.07	-0.07	-0.04	0.30
USA	13.24	-0.09	-0.09	-0.02	0.08	0.23	0.33	0.40	0.45	**0.48**
(13) *CPI*										
Mexico	11.92	0.31	0.16	-0.03	-0.20	**-0.33**	-0.34	-0.30	-0.26	-0.22
Turkey	5.64	0.14	0.10	0.07	-0.04	-0.18	-0.05	-0.03	0.04	0.04
USA	0.50	-0.59	**-0.61**	-0.57	-0.41	-0.22	-0.05	0.11	0.21	0.33
(14) *CPI based Inflation*										
Mexico	46.49	0.04	-0.10	-0.31	-0.54	**-0.65**	-0.59	-0.40	-0.18	-0.02
Turkey	14.49	-0.16	-0.18	-0.13	-0.16	-0.26	-0.19	-0.11	-0.00	0.21
USA	20.64	-0.08	-0.12	-0.02	0.14	0.30	0.33	**0.33**	0.32	0.31
(15) *Nominal Exchange Rate*										
Mexico	14.35	0.12	-0.14	-0.42	-0.67	**-0.69**	-0.57	-0.44	-0.30	-0.21
Turkey	11.13	0.15	0.02	-0.14	-0.30	**-0.47**	-0.27	-0.07	0.05	0.19
(16) *Annual Depreciation*										
Mexico	20.87	-0.32	-0.45	-0.62	**-0.71**	-0.60	-0.31	-0.01	0.31	0.40
Turkey	18.54	-0.06	-0.16	-0.27	-0.39	**-0.48**	-0.25	0.01	0.24	0.50
(17) *World CPI*										
Mexico	3.10	**-0.57**	-0.51	-0.41	-0.32	-0.22	-0.13	-0.03	0.03	0.05
Turkey	3.10	-0.00	-0.06	-0.10	-0.10	-0.07	-0.09	-0.14	-0.20	**-0.30**
(18) *World CPI Based Inflation*										
Mexico	25.19	-0.40	-0.24	-0.08	0.06	0.19	0.29	0.35	**0.37**	0.33
Turkey	25.19	-0.41	**-0.44**	-0.40	-0.29	-0.13	-0.03	0.01	0.03	-0.03
(19) *Industrial Countries' CPI*										
Mexico	0.42	0.35	**0.35**	0.33	0.28	0.23	0.17	0.09	-0.04	-0.14
Turkey	0.42	0.20	**0.33**	0.31	0.30	0.26	0.11	0.01	-0.06	-0.17
(20) *Industrial countries CPI Based Inflation*										
Mexico	13.41	0.21	0.07	-0.07	-0.18	-0.23	-0.26	-0.33	-0.39	**-0.41**
Turkey	13.41	**0.31**	0.29	0.26	0.22	0.11	-0.12	-0.24	-0.33	-0.31
(21) *Real Exchange Rate*										
Mexico	22.39	-0.18	-0.40	**-0.57**	-0.56	-0.43	-0.33	-0.31	-0.31	-0.26
Turkey	7.91	0.09	-0.05	-0.23	-0.37	**-0.52**	-0.32	-0.08	0.13	0.36
USA	3.38	0.16	0.29	0.34	**0.34**	0.26	0.18	0.06	0.04	0.02

Note: "Vol." denotes the percentage standard deviation of the cyclical component of the series.

Table 2 (Cont'd)

Variable X	Vol.	X_{t-4}	X_{t-3}	X_{t-2}	X_{t-1}	X_t	X_{t+1}	X_{t+2}	X_{t+3}	X_{t+4}
(22) *Short-Term Capital Inflows (Gross)*										
Mexico	554.63	0.26	0.39	**0.43**	0.33	0.06	-0.21	-0.37	-0.33	-0.24
Turkey	431.16	0.03	0.15	0.17	0.18	0.13	0.29	0.11	-0.05	-0.04
USA	117.72	0.06	0.11	0.16	0.10	0.23	0.20	0.02	-0.09	-0.12
(23) *Short-Term Capital Inflows (Net)*										
Mexico	587.32	0.03	0.25	0.36	**0.40**	0.32	0.38	0.34	0.22	0.13
Turkey	599.36	0.17	0.24	0.37	**0.55**	0.35	0.14	-0.21	-0.36	-0.30
USA	208.88	0.22	0.13	-0.02	0.09	-0.01	-0.05	-0.14	-0.12	-0.15
(24*) Long-Term Capital Inflows (Gross)*										
Mexico	556.48	0.05	0.14	0.27	0.20	0.13	0.09	0.11	0.17	0.06
Turkey	540.23	0.06	0.18	0.36	**0.67**	0.52	0.38	0.06	-0.39	-0.44
USA	89.33	0.14	0.16	0.08	0.18	0.21	0.19	0.19	0.11	0.03
(25*) Long-Term Capital Inflows (Net)*										
Mexico	589.43	0.27	0.34	**0.43**	0.37	0.09	-0.15	-0.37	-0.33	-0.21
Turkey	414.00	0.03	0.07	0.11	0.15	0.15	0.22	-0.04	0.03	0.02
USA	159.18	0.05	0.06	0.06	0.03	0.16	0.17	0.13	0.06	0.05
(26) *Real Interest Rate*										
Mexico	261.70	-0.12	-0.12	-0.08	0.03	0.22	0.36	0.38	0.30	0.14
Turkey	368.97	-0.04	-0.14	-0.13	-0.19	-0.02	0.12	0.19	0.20	0.03
USA	82.95	0.12	0.27	0.37	0.48	0.55	**0.60**	0.53	0.43	0.33

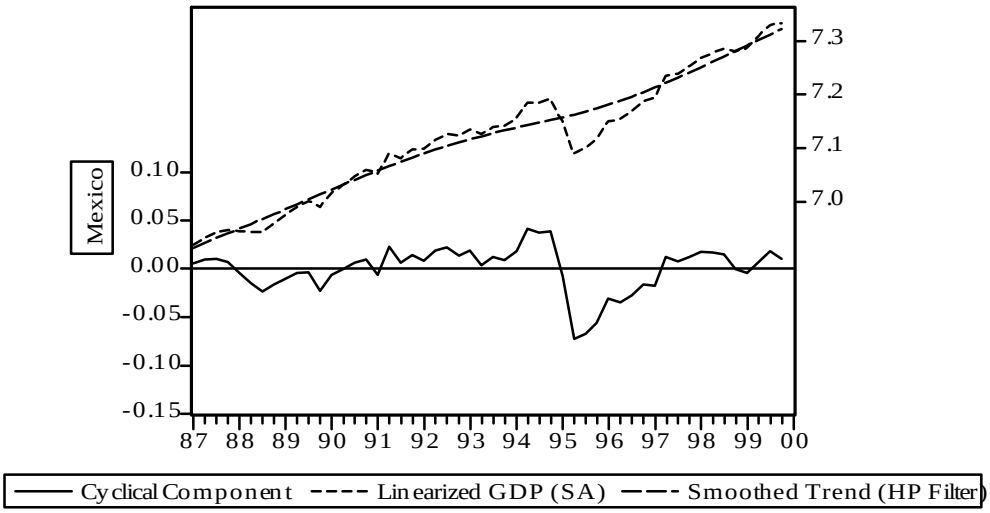
Note: "Vol." denotes the percentage standard deviation of the cyclical component of the series.

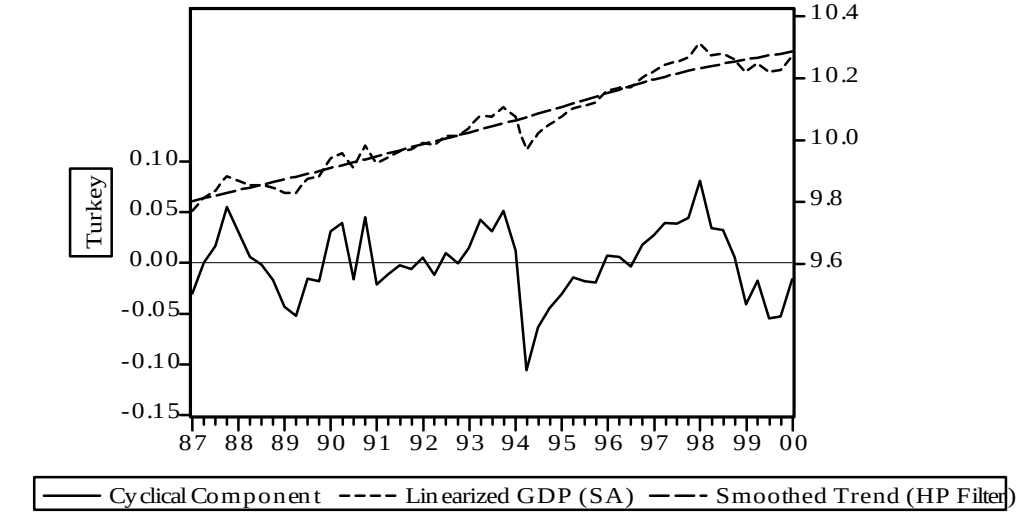
Table 3
The Factors of Production in Industry

Variable X	Vol.	X_{t-4}	X_{t-3}	X_{t-2}	X_{t-1}	X_t	X_{t+1}	X_{t+2}	X_{t+3}	X_{t+4}
Cross Correlations of Real GNP/GDP with										
(1) *Industrial Production Index*										
Mexico	3.10	0.14	0.31	0.56	0.79	**0.92**	0.66	0.31	-0.02	-0.23
Turkey	4.29	-0.11	0.16	0.38	0.63	**0.90**	0.57	0.31	-0.03	-0.27
USA	1.51	0.35	0.46	0.60	0.74	**0.82**	0.63	0.40	0.15	-0.03
(2) *Manufacturing Production Index*										
Mexico	3.03	0.22	0.33	0.53	0.71	**0.82**	0.55	0.20	-0.11	-0.29
Turkey	4.87	-0.13	0.15	0.37	0.62	**0.90**	0.57	0.30	-0.05	-0.27
USA	1.65	0.37	0.48	0.61	0.74	**0.81**	0.61	0.37	0.11	-0.08
Cross Correlations of Manufacturing Production Index with										
(3)*Employment in manufacturing*										
Mexico	2.93	0.21	0.33	0.52	0.75	**0.88**	0.84	0.67	0.43	0.27
Turkey	3.43	0.01	-0.06	-0.02	0.14	**0.40**	0.43	0.28	0.07	-0.13
USA	1.18	-0.04	0.14	0.36	0.60	0.83	**0.86**	0.79	0.69	0.58
(4)*Hours per Worker in Manufacturing*										
Mexico	3.53	0.20	0.35	0.52	0.73	**0.92**	0.80	0.64	0.40	0.22
Turkey	3.82	-0.04	-0.08	0.04	0.30	**0.61**	0.52	0.25	0.04	-0.20
USA	0.55	0.41	0.48	0.45	**0.49**	0.43	0.13	-0.12	-0.28	-0.35
(5) = (3)*(4) *Total Hours in Manufacturing*										
Mexico	6.41	0.20	0.34	0.52	0.75	**0.91**	0.82	0.66	0.42	0.26
Turkey	4.00	-0.01	-0.07	0.01	0.22	**0.52**	0.49	0.27	0.05	-0.17
USA	1.36	0.13	0.32	0.50	0.72	**0.90**	0.80	0.63	0.49	0.36
(6) = (2)/(3) *Productivity in Manufacturing in Terms of Employment*										
Mexico	1.51	-0.28	-0.14	-0.00	0.08	**0.36**	-0.06	-0.29	-0.37	-0.42
Turkey	4.72	-0.35	-0.07	0.27	0.53	**0.74**	0.29	-0.02	-0.22	-0.28
USA	4.14	0.28	0.28	0.19	0.12	0.04	-0.09	-0.24	-0.30	-0.36
(7) = (2)/(5) *Productivity in Manufacturing in Terms of Hours*										
Mexico	3.80	-0.30	-0.38	-0.48	-0.64	-0.71	**-0.77**	-0.70	-0.52	-0.37
Turkey	6.21	-0.25	-0.03	0.16	0.20	0.18	-0.10	-0.15	-0.17	-0.07
USA	2.09	-0.28	-0.22	-0.17	-0.03	0.10	0.11	0.13	0.15	0.21
(8*) Real Hourly Wages in Manufacturing*										
Mexico	4.70	-0.65	-0.56	-0.37	-0.07	0.20	0.36	**0.47**	0.44	0.43
Turkey	10.16	-0.10	-0.13	-0.01	0.18	-0.03	0.12	0.14	0.09	0.20
USA	0.33	-0.24	-0.24	-0.30	-0.29	-0.24	-0.30	-0.35	-0.21	-0.08
Cross Correlation of Real Hourly Wages in Manufacturing with										
(9) *Government Final Consumption*										
Mexico	7.97	0.36	0.58	0.68	0.69	**0.70**	0.60	0.48	0.31	0.15
Turkey	3.48	0.06	0.12	0.17	0.15	0.15	**0.34**	-0.02	0.26	0.01
USA	0.94	0.21	0.29	0.42	0.33	0.37	**0.45**	0.36	0.28	0.24

Note: “Vol.” denotes the percentage standard deviation of the cyclical component of the series.

Figure 1:
Real GDP, Smoothed Trend and the Cyclical Component





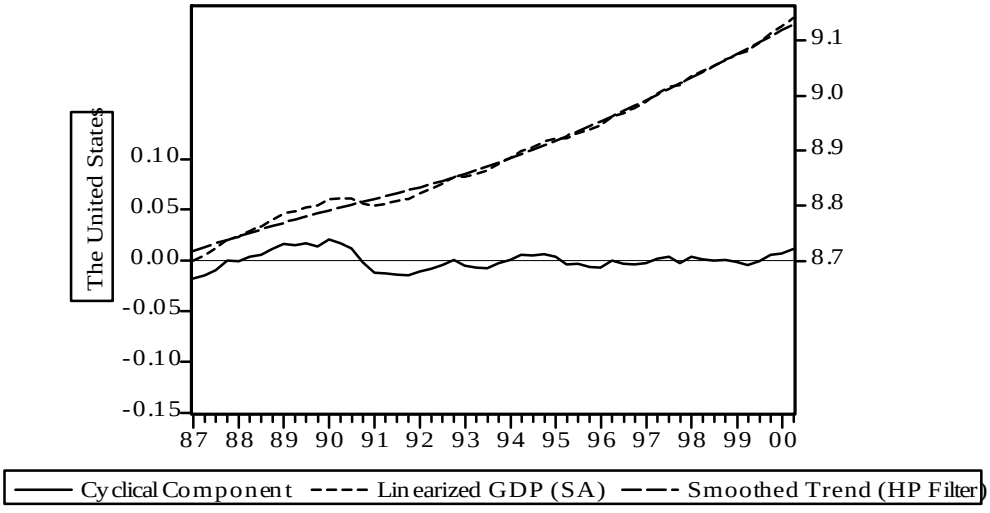
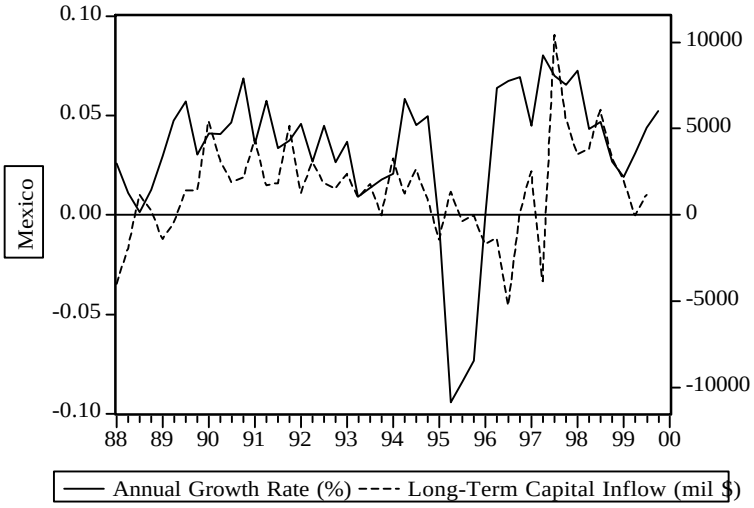
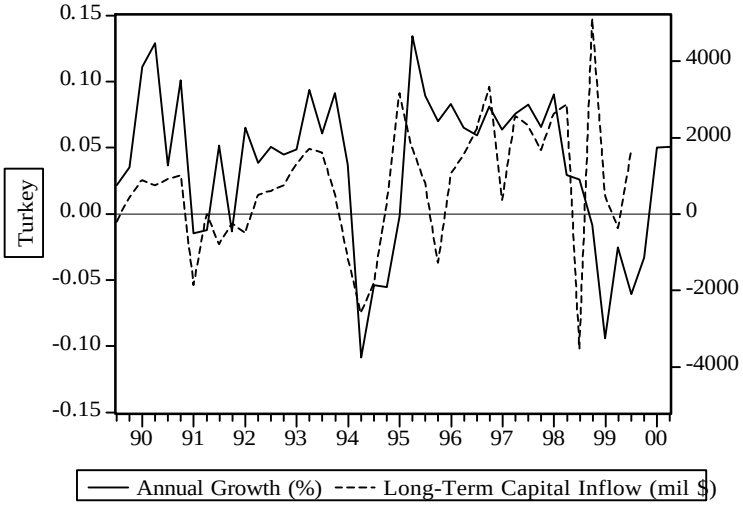


Figure 2a:
Net Long-Term Capital Inflows and Growth





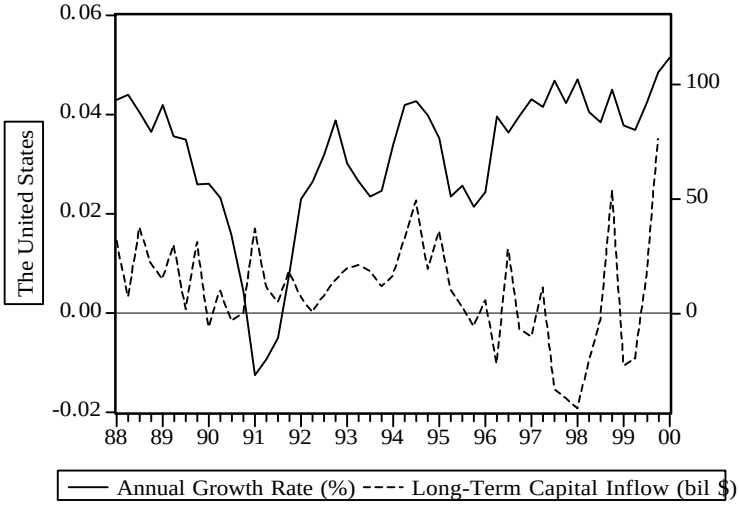
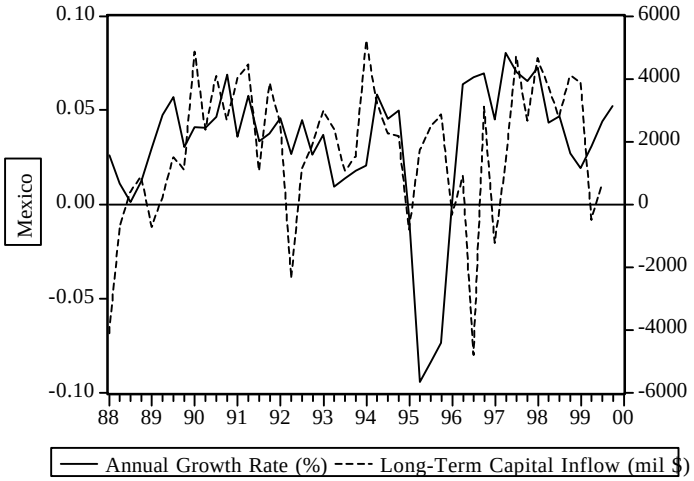
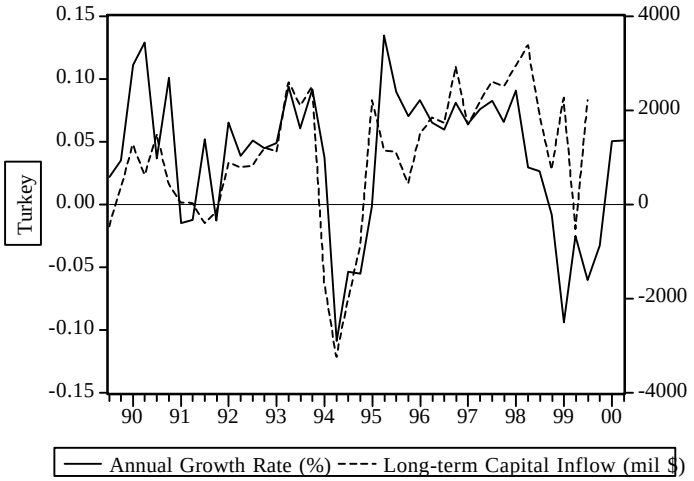


Figure 2b:
Gross Long-Term Capital Inflows and Growth





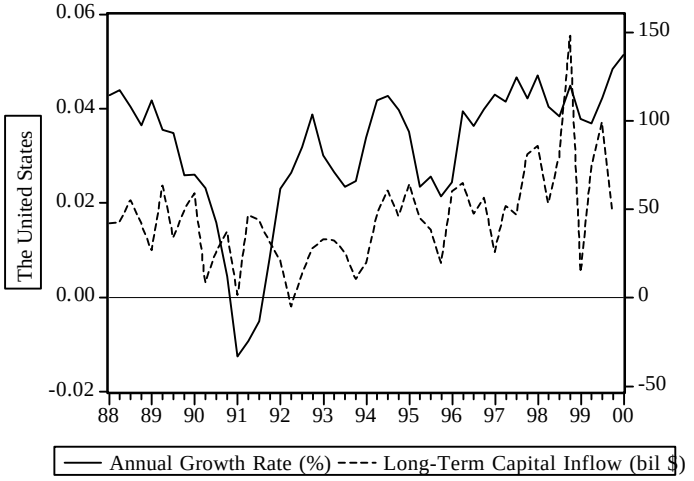
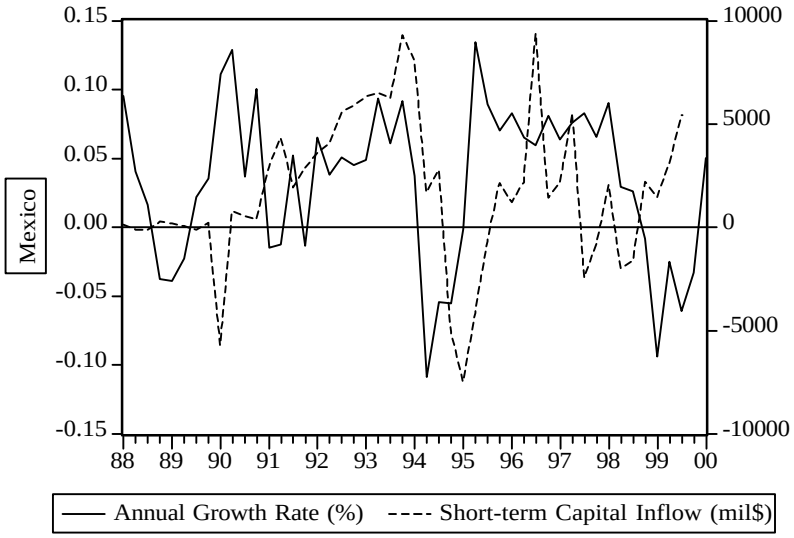
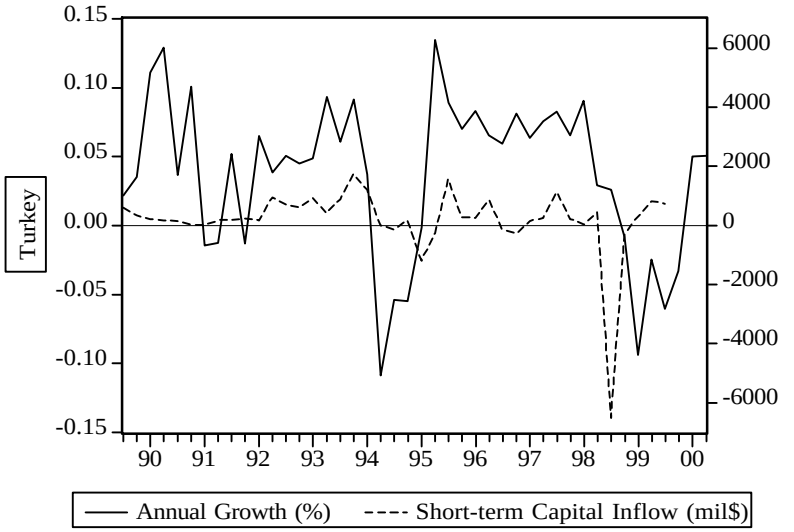


Figure 2c:
Net Short-Term Capital Inflows and Growth





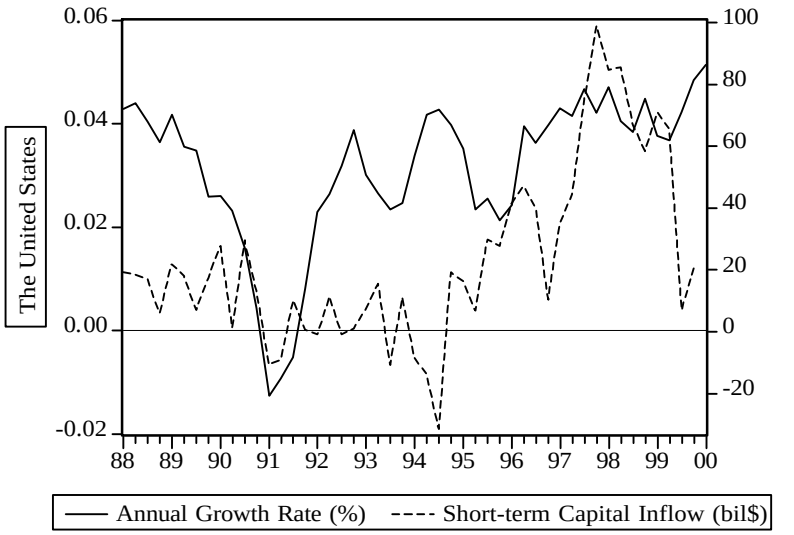
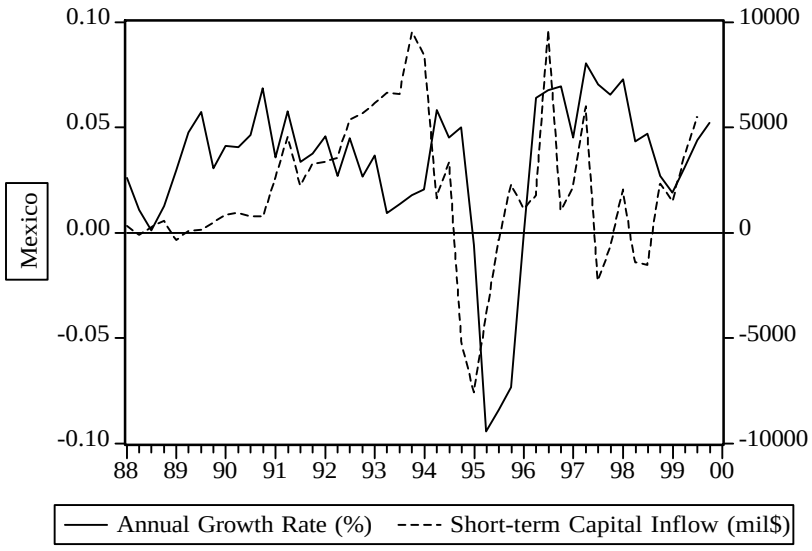
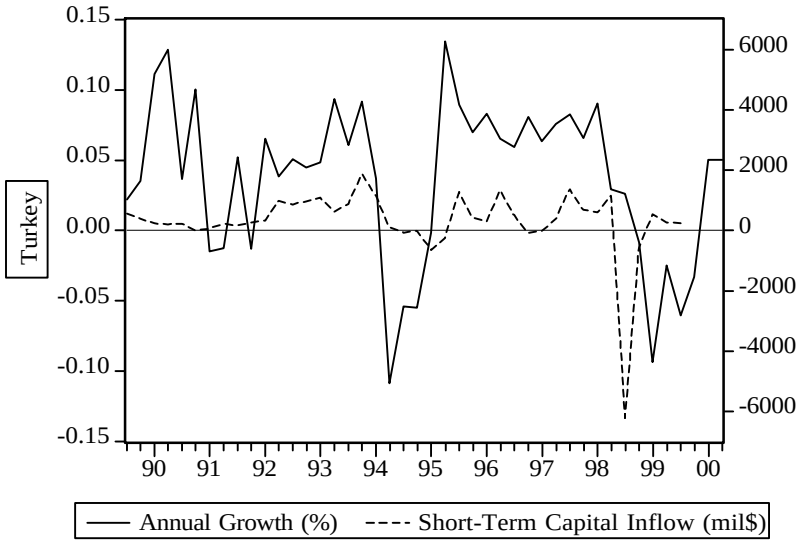
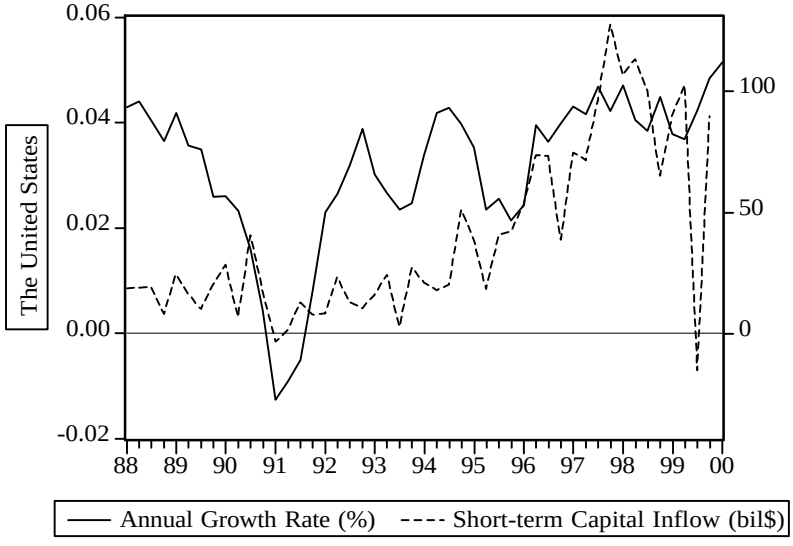


Figure 2d:
Gross Short-Term Capital Inflows and Growth







Appendix A
Capital Flows to Mexico and Turkey in the Post-1987 Period

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	**Average**	**Median**	**Std**
GDP	(in Billion USD)														
Mexico	183.4	223.1	263.0	314.3	364.2	402.6	420.2	286.1	329.4	401.4	414.8	183.4			
Turkey	88.4	103.8	150.5	153.0	164.3	187.7	130.7	169.3	181.5	189.9	198.0	88.4			
Gross Short-Term	(in Million USD)														
Mexico	-1,002	1,001	354	3,369	12,741	18,041	28,919	8,182.2	-9,714.7	13,417.2	5,038	1,294	6,803.3	4,203.5	10,227.3
Turkey	307	1,184	1,445	681	714	3,165	4,480	1,123.0	703.0	1,950.0	2,344	-5,089	1,083.9	1,153.5	2,286.3
Net Short-Term	(in Million USD)														
Mexico	-1,399	121	298	-3,985	12,138	19,206	28,355	7,415.4	-10,376.9	13,960.8	4,330	526	5,882.5	2,428.0	10,869.1
Turkey	282	1,178	1,386	547	623	2,411	3,917	1,158.0	237.0	570.0	1,634	-6,386	629.7	890.5	2,442.9
Gross Long-Term	(in Million USD)														
Mexico	2,733	-3,742	1,926	13,771	13,396	3,446	8,443	13,274.6	6,583.9	-943.9	7,498	15,251	6,803.1	7,040.9	6,261.9
Turkey	2,563	-708	-977	3,883	-430	3,740	8,351	-7,726.0	4,902.0	7,972.0	8,983	8,990	3,295.2	3,811.5	5,094.5
Net Long-Term	(in Million USD)														
Mexico	-1,668	-4,616	812	12,426	13,001	7,833	5,405	8,371.3	-110.4	-7,828.8	14,923.4	16,782	5,444.2	6,619.0	8,083.7
Turkey	1,609	-2,136	-606	3,490	-3,020	1,237	5,046	-5,352.0	4,406.0	8,193.0	6,982	7,159	2,250.7	2,549.5	4,371.5

Source: International Financial Statistics.
Gross Short-term capital flows include portfolio investment of non-residents.
Gross Long-term capital flows include direct investment and other investment by non-residents.
Net flows deduct the amount of investment by residents to abroad from Gross flows

APPENDIX B

Sensitivity of Persistence and Volatility to Different Detrending Procedures

MEXICO	Volatility	t	t-1	t-2	t-3	t-4
GDP						
HP	2.34	1.00	0.77	0.48	0.18	0.01
TS	2.92	1.00	0.84	0.62	0.40	0.25
DS	1.64	1.00	0.15	0.05	-0.21	-0.24
Q4	0.51	1.00	0.73	0.40	0.01	-0.22
IPI						
HP	3.10	1.00	0.78	0.47	0.17	-0.04
TS	4.09	1.00	0.85	0.64	0.44	0.28
DS	2.12	1.00	0.26	0.05	-0.15	-0.41
Q4	1.08	1.00	0.73	0.37	-0.01	-0.25

TURKEY	Volatility	t	t-1	t-2	t-3	t-4
GDP						
HP	3.48	1.00	0.58	0.32	0.08	-0.22
TS	3.76	1.00	0.64	0.41	0.17	-0.14
DS	3.19	1.00	-0.16	0.01	0.11	-0.37
Q4	0.56	1.00	0.54	0.29	0.01	-0.40
IPI						
HP	4.29	1.00	0.64	0.33	0.01	-0.19
TS	4.67	1.00	0.70	0.41	0.11	-0.10
DS	3.66	1.00	-0.02	0.01	-0.09	-0.33
Q4	1.60	1.00	0.62	0.24	-0.13	-0.40

USA	Volatility	t	t-1	t-2	t-3	t-4
GDP						
HP	0.89	1.00	0.82	0.59	0.35	0.14
TS	1.16	1.00	0.83	0.62	0.39	0.20
DS	0.52	1.00	0.43	0.35	0.22	0.10
Q4	0.17	1.00	0.86	0.67	0.46	0.28
IPI						
HP	1.51	1.00	0.80	0.58	0.43	0.26
TS	1.98	1.00	0.85	0.68	0.52	0.35
DS	0.96	1.00	0.32	0.05	0.30	0.13
Q4	0.53	1.00	0.85	0.68	0.56	0.40

Notes: HP= Hodrick-Prescott filter; DS= first differences of natural logarithm of variables; TS= residuals from a regression regressing each variable expressed in natural logarithm on a quadratic trend; Q4= fourth differences of natural logarithm of variables.